INTEGRATED SPEECH SYNTHESIZER WITH AN AUTOMATIC IDENTIFICATION OF SPEAKER CONNECTIONS AND IDENTIFICATION METHOD USED THEREOF

FIELD OF THE INVENTION

The present invention relates generally to an integrated speech synthesizer, and more particularly, to an integrated speech synthesizer with an automatic identification of speaker connections to determine an initial value thereof and identification method used thereof.

BACKGROUND OF THE INVENTION

The speech synthesizer is used to convert digitized sound information to analog signal and output to a speaker to regenerate the sound. Fig. 1A shows a waveform of a period of sound and the digitized range of the wave. When digitally encoded with 7-bits pulse code modulation (PCM), it normally uses 40H as the central point, and the speech signal varies up and down around the central point, that is varies in-between 00H and 7FH.

Fig. 2 shows a functional block diagram of a conventional PCM speech synthesizer connected with a speaker, in which the PCM codes are stored in the PCM encode register 22. When the speech synthesizer 20 is enabled and start to operation, the PCM codes that stored in the PCM encode register 22 are sent out to the PCM speech synthesis unit 24 in order. The PCM speech synthesis unit 24 converts the received PCM codes to an analog signal and then sends to the output terminal VO. The current from the output terminal VO is amplified by a transistor 26 to drive the speaker 50 to produce sounds. To save the power during the speech synthesizer 20 is turned off, there shouldn't be any current from the output terminal VO, therefore the initial value of the PCM encode register 22 is 00H. As shown in Fig. 1B, when the speech synthesizer 20 is enabled, PCM codes are sent to the PCM speech synthesis unit 24, and the value changed from 00H to 40H, that makes an large instant current change on the output terminal VO and thus produces burst noises. On the other hand, when the operation of the speech synthesizer 20 stops, PCM code changes from 40H to 00H, that also makes an large instant current change on the output terminal VO and produces burst noises. For improvement, it always adds a rising wave and a falling wave before and after the sound data respectively to avoid the large instant current change and burst noises, as shown in Fig. 1C.

Another type of speech synthesizer that drives the speaker

directly, for example the push-pull drive type, is shown in Fig. 3, which processes with pulse width modulation (PWM). The PWM speech synthesizer 30 includes a PWM encode register 32 and a PWM speech synthesis unit 34. The PWM speech synthesis unit 34 has two output pins and sends out signal with push-pull type to drive the speaker 50 directly. The speech synthesizer 30 uses 40H as the zero point of the speech signal, thereby the initial value is 40H before the speech synthesizer 30 is enabled. In such circumstances, both the initial value and the central point of the speech signal are 40H, it is therefore not necessary to add a rising wave and a falling wave before and after the sound data.

However, when it is intended to integrate the PCM type with the direct drive type speech synthesizers, it is necessary to provide a mechanism to decide which type of speech synthesis unit to be enabled since the speaker connection and the initial value are different for them. Typically, there are two methods to provide needed information. The first one is to provide an input pin for selection. However it needs more chip area, and it requests the user to control the state of the input pin. When the input pin is not under good control, the speech synthesizer can not function correctly, thus it is inconvenient for applications. The second method is to select by mask (in the encoding layer or metal layer). Once the chip is fabricated, it is impossible to change the speaker connection and thus has less flexibility.

SUMMARY OF THE INVENTION

To solve problems described in the above, an object of the present invention is a speech synthesizer with integrated PCM type and direct drive type, which is enable to automatically identify the speaker connection and set up initial value and related parameters.

According to the present invention, an integrated speech synthesizer with an automatic identification of speaker connections comprises an encode register for storage of encoded digital data of sound, a first speech synthesis unit connected to the encode register to convert the digitized sound data from the output terminal of the encode register to a first analog signal and send out the first analog signal through a first output terminal, a second speech synthesis unit connected to the encode register to convert the digitized sound data from the output terminal of the encode register to a second analog signal and send out the second analog signal through the first output terminal and a second output terminal, and a state register connected to the first output terminal to store the state of the first output terminal before the speech synthesizer is enabled, wherein the initial value and related parameters for the speech synthesizer is det up in reference to the state stored in the state register.

A method, according to the present invention, for automatic identification of speaker connections for an integrated speech synthesizer that includes a PCM type speech synthesis unit to output a first analog signal through a first output terminal and a direct drive type speech synthesis unit to output a second analog signal through the first output terminal and a second output terminal comprises:

1. sending out a preset voltage from the second output terminal;
2. storing the state of the first output terminal in a state register before the speech synthesizer is enabled; and
3. setting up the initial value and related parameters for the speech synthesizer in reference to the state stored in the state register.

Due to the state of the first output terminal stored in a state register for the different speaker connections before the speech synthesizer is enabled and the control of setting up the initial values for different units in reference to the state stored in the state register, the integrated speech synthesizer according to the present invent is convenient and flexible for uses. Moreover, the cost is reduced since no additional pin is needed.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, reference may be had to the following description of exemplary embodiments thereof, considered in conjunction with the accompanying drawings, in which:

Fig. 1 shows a waveform of a period of sound and the digitized range of the wave;

Fig. 2 is a functional block diagram of a conventional PCM speech synthesizer connected with a speaker;

Fig. 3 is a functional block diagram of a conventional PWM speech synthesizer connected with a speaker;

Fig. 4 is a functional block diagram of an integrated speech synthesizer with an automatic identification of speaker connections according to the present invention;

Fig. 5 is a functional block diagram to show when the first output terminal of the integrated speech synthesizer shown in Fig. 4 is connected to a speaker; and

Fig. 6 is a functional block diagram to show when the first and

second output terminals of the integrated speech synthesizer shown in Fig. 4 are connected to a speaker.

DETAILED DESCRIPTION OF THE INVENTION

A functional block diagram of an integrated speech synthesizer with an automatic identification of speaker connections according to the present invention is shown in Fig. 4, in which an integrated speech synthesizer 40 comprises an encode register 41, a PCM speech synthesis unit 24, a PWM speech synthesis unit 34, and a state register 42. The encode register 41 is provided to store the digitized codes of sound wave. The input of the PCM speech synthesis unit 24 is connected to the encode register 41 to convert the digitized codes from the encode register 41 to an analog signal, and send out the current of the analog signal through a first output terminal VO1. The PWM speech synthesis unit 34 is also connected to the encode register 41 to convert the digitized codes from the encode register 41 to an analog signal and send out the current of the analog signal with push-pull type through the first output terminal VO1 and a second output terminal VO2. The first output terminal VO1 is set to high impedance before the speech synthesizer 40 is enabled.

On the other hand, the input of the state register 42 is

connected to the first output terminal VO1 to latch the state of the first output terminal VO1 by use of a pulse signal CK to identify the speaker connections before the speech synthesizer 40 is enabled. The output terminal of the state register 42 is connected to the encode register 41, PCM speech synthesis unit 24, PWM speech synthesis unit 34 and other units (not shown) ,if needed, to provide the state for the initial value set up and for control and setting of other related units.

Figs. 5 and 6 illustrate the theory of automatic identification of speaker connections according to the present invention.

Fig. 5 shows the state that a speaker is connected to the first output terminal of the integrated speech synthesizer through a transistor, in which one terminal of the speaker 50 is connected to a power supply, the other terminal is connected to the collector of an NPN transistor 26 that has its emitter grounded and base connected to the first output terminal VO1. One terminal of a bypass resister 28 is grounded and the other terminal is connected to the first output terminal VO1. With such connection and before the synthesis units 24 and 34 are enabled, the first output terminal VO1 is in high impedance "Z" state, and there is a P-N junction equivalent diode when see from the first output terminal VO1 to the NPN transistor 26, thus the voltage of the first output terminal VO1 is pulled down to low level "0" by the equivalent diode or by the bypass

resistor 28.

Fig. 6 shows the state that the speaker is directly connected to the first and second output terminals of the integrated speech synthesizer, in which one terminal of the speaker 50 is connected to the first output terminal VO1 and the other terminal is connected to the second output terminal VO2. With such connection and before the synthesis units 24 and 34 are enabled, when a high voltage is supplied to the second output terminal VO2, the voltage on the first output terminal VO1 is pulled up to high level "1" by the speaker 50 for the resistor of the speaker 50 is about 4-64 Ω and the first output terminal VO1 is in high impedance "Z" state.

According to the results concluded in the above, different speaker connections cause different voltage states on the first output terminal VO1, that is high voltage "1" and low voltage "0". After the speaker 50 is connected to the speech synthesizer 40 and before the speech synthesizer 40 is enabled, a high voltage is sent to the second output terminal VO2 and the state register 42 stores the state of the first output terminal VO1 in advance, then the connection of the speaker 50 is identified in reference to the state stored in the state register 42 to enable the related speech synthesis unit. For example, when the speaker 50 is connected in the manner shown in Fig. 5 the state in the state register 42 is "0", and when the speaker 50 is connected in the manner shown in Fig. 6 the

state in state register 42 is "1". As a result, the state register 42 can send the state value DA_FLAG to the encode register 41, PCM speech synthesis unit 24, PWM speech synthesis unit 34 and other units (not shown) to indicate the connection state of the speaker 50 for the control parameters and setting. For example, when the state value DA_FLAG is "0", the PCM speech synthesis unit 24 can be enabled and sets up the initial value to 00H, thereby adding a rising wave and a falling wave before and after the encoded sound data respectively. When the state value DA_FLAG is "1", the PWM speech synthesis unit 34 can be enabled and sets up the initial value to 40H.

While the present invention has been described in conjunction with preferred embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. For example, in the above embodiment the PWM is used for the second speech synthesis unit, however, other speech synthesis unit with direct drive function can also be applied. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and scope thereof as set forth in the appended claims.